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[Document] Specification

[Title of the Invention] LASER BEAM SCANNER

[Scope of the Claims]

[Claim 1]

A laser beam scanner, comprising:

a plurality of laser light sources;

deflecting scanning means that deflectingly scans the respective laser beams emitted from the plurality of laser light sources;

first collecting means that is arranged between the deflecting scanning means and a photosensitive body and collects the laser beams to the photosensitive body; and

detecting means that detects a scanning start timing of the laser beams by detecting the laser beams deflectingly scanned by the deflecting scanning means, the laser beam scanner collecting the laser beams deflectingly scanned by the deflecting scanning means to the photosensitive body via the first collecting means;

wherein a horizontal magnification in a sub scanning direction on an optical path from the deflecting scanning means to the detecting means is smaller than a horizontal magnification in a sub scanning direction on an optical path from the deflecting scanning means to the photosensitive body.

[Claim 2]

The laser beam scanner as set forth in claim 1, further comprising:

second collecting means that collects the respective laser beams emitted from the plurality of laser light sources to the deflecting scanning means; and

third collecting means that collects the laser beams emitted from the first collecting means to the detecting means,

wherein the second and third collecting means are the same single directionality collecting lens.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

This invention relates to a laser beam scanner that exposes an image by scanning a laser beam onto a photosensitive body.

[0002]

[Prior Art]

Conventionally, as this type of laser beam scanner, for example, a scanner shown in Fig. 6 is known. Fig. 6 is an explanatory view showing a main structure of a conventional laser beam scanner.

A laser beam scanner 100 is provided with a laser light source 101 integrated with a semiconductor laser element and a collimating lens, a cylinder lens 102 that collects a laser beam emitted from the laser light source 101, a polygon mirror 103 that deflects the laser beam that has gone through the cylinder lens 102, a first fθ lens 104 and a second fθ lens 105 that collect the laser beam deflected by the polygon mirror 103 onto a photosensitive drum 110, a light detecting element 106 that detects the laser beam that has gone through the second fθ lens 105, and a BD imaging lens 107 that collects the laser beam that has gone through the second fθ lens 105 to the BD sensor 106.

The first fθ lens 104 is provided with power mainly in a main scanning direction, and the second fθ lens 105 is provided with power mainly in a sub scanning direction. The BD sensor 106 detects a scanning start timing of the laser beam emitted from the laser light source 101 and is arranged within a range outside of an effective scanning region in the photosensitive drum 110 and in a position at which the laser beam is collected.

Furthermore, a laser beam scanner is also known in which the laser beam that has gone through the second fθ lens 105 is reflected by a mirror, and the reflected light is collected at the BD sensor 106 by being caused to pass through the BD imaging lens 107.

[0003]

[Problem to be Resolved by the Invention]

Meanwhile, a multi-laser beam scanner using a plurality of laser beams for increasing an exposure speed is known. However, in this multi-laser beam scanner, in order to detect a scanning start timing of the respective laser beams separated from each other in the sub scanning direction, it is necessary to enter the respective laser beams into the BD sensor. In order to reliably enter all the respective laser beams, separate from each other in the sub scanning direction, to the BD sensor, a BD sensor needs to be used that has a light receiving surface in which the width is wide in the sub scanning direction.

However, there is a problem that as the light receiving surface increases, the capacitance of the sensor portion increases proportionally, so responsiveness becomes poor.

Additionally, depending on the position of the light receiving surface, irregularity of sensitivity in terms of manufacturing exists. Therefore, when the positions at which the respective laser beams enter are separate from each other, because of the irregularity of the

sensitivity, there is a problem that the scanning start timing of the respective laser beams is shifted.

In addition, because the light receiving surface is large, the BD sensor becomes large; thus, there is a problem that the space of mounting the BD sensor increases, and making the product using the multi-laser beam scanner smaller may be difficult.

[0004]

Thus, this invention reflects on the above-mentioned problems. An object of this invention is to realize a laser beam scanner that can reduces the necessary width in the sub scanning direction in order to enter the respective laser beams emitted from a plurality of laser light sources into the BD sensor.

[0005]

[Means of Solving the Problem, Operation, and Effects of the Invention]

In order to accomplish the above-mentioned object, in the invention described in claims 1 and 2, this invention uses technical means, in which the laser beam scanner is provided with a plurality of laser light sources; deflecting scanning means that deflectingly scans the respective laser beams emitted from the plurality of laser light sources; first collecting means that is arranged between the deflecting scanning means and a photosensitive body and collects the laser beams to the photosensitive body; and detecting means that detects a scanning start timing of the laser beams by detecting the laser beams deflectingly scanned by the deflecting scanning means, the laser beam scanner collecting the laser beams deflectingly scanned by the deflecting scanning means to the photosensitive body via the first collecting means; wherein a horizontal magnification in a sub scanning direction on an optical path from the deflecting scanning means

to the detecting means is smaller than a horizontal magnification in a sub scanning direction on an optical path from the deflecting scanning means to the photosensitive body.

[0006]

The respective laser beams emitted from a plurality of laser light sources are deflectingly scanned by a deflecting scanning means. The respective deflectingly scanned laser beams are deflected by the first deflecting means at least in the sub scanning direction, and the respective deflected laser beams are collected in the photosensitive body. Furthermore, the detecting means detects the laser beams deflectingly scanned by the deflecting scanning means so as to detect the scanning start timing of the laser beams.

Furthermore, the horizontal magnification in the sub scanning direction on the optical path from the deflecting scanning means to the detecting means is smaller than the horizontal magnification in the sub scanning direction on the optical path from the deflecting scanning means to the photosensitive body. Therefore, the entering position of the respective laser beams entering from the deflecting scanning means to the detecting means can be closer, compared to the case in which the above-mentioned relationship does not exist.

Therefore, the light receiving surface of the detecting means can be designed to be small, the capacitance can be reduced. Therefore, responsiveness can be improved.

In addition, the effects due to the irregularity of the sensitivity depending on the position of the light receiving surface of the detecting means can be made small, so the shifting of the scanning start timing of the respective laser beams can be also made small.

Additionally, the BD sensor can be made small by making the light receiving surface small, so the space of mounting the BD sensor can be reduced; thus, the product using the multi-laser beam scanner can be also made small.

[0007]

In the invention described in claim 2, in the laser beam scanner described in claim 1, technical means is used in which the laser beam scanner is provided with second collecting means that collects the respective laser beams emitted from the plurality of laser light sources to the deflecting scanning means; and third collecting means that collects the laser beams emitted from the first collecting means to the detecting means, wherein the second and third collecting means are the same single directionality collecting lens.

[0008]

That is, the second collecting means that collects the respective laser beams emitted from a plurality of laser light sources to the deflecting scanning means and the third collecting means that collects the laser beams emitted from the first collecting means to the detecting means are the same single directionality collecting lens. Therefore, the number of parts in common increases, and the manufacturing cost of the laser beam scanner can be reduced, compared to the case in which different individual parts are used.

[0009]

[Embodiments]

[First Embodiment]

The following explains a first embodiment of a laser beam scanner related to this invention with reference to the drawings. Furthermore, in the following respective embodiments, a laser beam scanner used for a laser printer as a laser beam scanner related to this invention is used as an example (main structure of a laser printer).

First, the main structure of a laser printer is explained with reference to Fig. 1. Fig. 1 is an explanatory view showing a partial cross section of a laser printer 1 in a perspective view

from a direction perpendicular to a paper transfer direction. Additionally, in Fig. 1, the surface shown by arrow X is a front surface, the surface shown by arrow Y is a top surface, and the side closest to the reader is a left side surface.

[0010]

With respect to the laser printer 1, the overall shape is formed in a substantially rectangular parallelepiped shape by a main body frame 11. Under the main body frame 11, a paper feeding portion 19 is arranged, which houses paper P and feeds the paper. The paper P is transferred to a transfer portion 18 from the paper feeding portion 19 via the front portion of the device. Above the transfer portion 18, a developer 17 is arranged, which is integrally constituted as a process unit. Furthermore, above the developer 17, a laser beam scanner 12 of this embodiment is arranged. A photosensitive body drum 77 provided in the developer 17 is uniformly charged by a charger 78 arranged above the photosensitive body drum 77. The laser beam scanner 12 forms a latent image by scanning on the photosensitive body drum 77 one or a plurality of laser beams modulated according to an image signal.

[0011]

Meanwhile, toner T housed in the developer 17 is supplied to a developing roller 75 by a supply roller 74. The toner T adhered to the circumferential surface of the developing roller 75 develops a latent image formed in the photosensitive body drum 77, the image is made to be clearly presented, and an image is formed by a toner. Furthermore, the toner T adhered to the circumferential surface of the developing roller 75 is controlled by a layer thickness regulation blade 76 so as to have an appropriate layer thickness. The paper P transferred to the transfer portion 18 is pinched between the photosensitive body drum 77 and the transfer roller 87, so the image on the photosensitive body drum 77 is transferred to the paper P and is transferred to the

fixing portion 15 at the rear. Subsequently, the paper P is pinched between a heat roller 52 and a pressure roller 54, so the toner on the paper P is dissolved and permeates to fiber of the paper P, and the paper P is transferred to the rear portion. Subsequently, the paper P is discharged to a printed paper mounting portion 69 via a paper discharging portion 16 by a first paper discharging roller 55, a first follow-up roller 56 that follows the first paper discharging roller 55, and a second follow-up roller 57.

[0012]

(Main Structure of Laser Beam Scanner)

The following explains a main structure of a laser beam scanner 12 with reference to Fig. 2.

Furthermore, in reality, a plurality of laser beams are used, but the respective laser beams are shown as one laser beam in Fig. 2.

The laser beam scanner 12 is provided with a laser light source 47 in which a laser diode and a collimating lens are integrated, a first cylinder lens 13 that is a single directionality collecting lens, a polygon mirror 23, a first fθ lens 21, a second fθ lens 22, a mirror 25, a second cylinder lens 14 that is a single directionality collecting lens, and a BD sensor 49.

The laser beam LB emitted from the laser light source 47 is collected in the sub scanning direction by the first cylinder lens 13, which has power in the sub scanning direction, and is projected onto the polygon mirror 23. The polygon mirror 23 is rotated by an undepicted scanner motor at a high speed in a direction shown by the arrow and is deflected so as to conformally move the laser beam LB. The conformally moved laser beam LB is collected mainly in the main scanning direction by the first fθ lens 21 having power mainly in the main scanning direction, is further collected mainly in the sub scanning direction by the second fθ lens 22 having power

mainly in the sub scanning direction, and is irradiated so as to be moved on the photosensitive body drum 77 in the main scanning direction. Thus, a latent image is formed on the photosensitive body drum 77.

[0013]

Additionally, the laser beam LB is reflected by the mirror 25 immediately before scanning the photosensitive body drum 77. The reflected laser beam LB does not go through the second fθ lens 22 that has power in the sub scanning direction. Thus, by causing the laser beam to pass through the second cylinder lens 14, which has power in the sub scanning direction, it is collected mainly in the sub scanning direction. Additionally, the laser beam collected by the second cylinder lens 14 mainly in the sub scanning direction, and is received by the BD sensor 49.

In addition, the photosensitive body drum 77 is rotated by an undepicted stepping motor. As the photosensitive body drum 77 is rotated, the photosensitive body formed on the surface of the photosensitive body drum 77 is relatively sub-scanned, and sequentially irradiated so as to form a latent image by exposing the entire photosensitive body.

[0014]

(Horizontal Magnification in the Sub scanning direction)

The following explains the horizontal magnification in the sub scanning direction on the optical path (hereafter referred to as "writing optical path") from the polygon mirror 23 to the photosensitive body drum 77 and the horizontal magnification in the sub scanning direction on the optical path (hereafter referred to as "BD optical path") from the polygon mirror 23 to the BD sensor 49 with reference to Figs. 3 and 4.

Fig. 3(A) is a schematic view showing a cross section of a writing optical path in the sub scanning direction. Fig. 3(B) is a schematic view showing a cross section of the BD optical path in the sub scanning direction. Fig. 4(A) is an explanatory view showing the relationship between a beam spot on the writing optical path and a light receiving surface 49a of the BD sensor 49. Fig. 4(B) is an explanatory view showing the relationship between the beam spot on the BD optical path and the light receiving surface 49a of the BD sensor 49.

Here, a multi-beam laser scanner using four laser beams is used as an example.

[0015]

According to Fig. 3(A), the horizontal magnification of the writing optical path in the sub scanning direction is L2/L1. According to Fig. 3(B), the horizontal magnification of the BD optical path in the sub scanning direction is L4/L3.

[0016]

$L2/L1 > L4/L3$ … First equation

[0017]

The above-mentioned relationship is established. That is, the second cylinder lens 14 (Fig. 2) arranged on the BD optical path is designed to have a curvature to satisfy the relationship of the first equation.

Here, if the relationship between the beam spot on the writing optical path and the light receiving surface 49a of the BD sensor 49 is analyzed, as shown in Fig. 4(A), the four beam spots BS1 - BS4 are respectively irradiated onto the photosensitive body drum 77. Adjacent beam spots are separated from each other at a distance x1 in the main scanning direction, and at a distance y1 in the sub scanning direction.

[0018]

Here, conventionally, if the relationship of the first equation is not established, for example, in the case of $L2/L1 = L4/L3$, if the four beam spots BS1 - BS4 are incident to the light receiving surface 49a of the BD sensor 49 in the order of BS1 → BS2 → BS3 →BS4, the needed width d1 in the sub scanning direction of the light receiving surface 49a is $d1 > 3xy1$. If the number of laser beams is n ($\geqq 2$),

[0019]

$d1 > (n - 1)y1$ ... Second equation.

[0020]

The above-mentioned equation is established.

Meanwhile, if the relationship between the beam spots on the BD optical path of the laser beam scanner 12 of this embodiment and the light receiving surface 49a of the BD sensor 49 is analyzed, as shown in Fig. 4(B), the four beam spots BS1 - BS4 are respectively irradiated on the photosensitive body drum 77. Adjacent beams spots are separated from each other at a distance x2 in the main scanning direction, and at a distance y2 in the sub scanning direction.

Here, the relationship between y1 and y2 is established as follows:

[0021]

$y1 > y2$ ... Third equation

[0022]

The relationship between x1 and x2 is arbitrary, but if a lens having power in the sub scanning direction is used, such as the second cylinder lens 14, the following equation can be established.

[0023]

$x1 = x2$ ... Fourth equation

[0024]

In order to receive all the four laser beams BS1 - BS4 on the BD optical path, if the width of the light receiving surface 49a of the BD sensor 49 in the sub scanning direction is d2, the following equation can be established.

[0025]

$d2 > (n - 1)y2$ ... Fifth equation

[0026]

Here, according to the third equation, $y1 > y2$, so the following equation can be established.

[0027]

$d2 < d1$ ... Sixth equation

[0028]

That is, by satisfying the condition $L2/L1 > L4/L3$ of the first equation, the width of the light receiving surface 49a of the BD sensor 48 in the sub scanning direction can be shortened.

[0029]

(Effects of the First Embodiment)

If the laser beam scanner 12 of the first embodiment is used, the width of the light receiving surface 49a of the BD sensor 49 in the sub scanning direction can be shortened by (d1-d2), so the capacitance of the sensor portion can be reduced. Thus, responsiveness can be improved.

Furthermore, the entering position for the light receiving surface 49a of the respective laser beams emitted from the four laser light sources can be made as close as possible. Thus, effects of the irregularity of the sensitivity in terms of manufacturing on the light receiving

surface can be minimized (the respective laser beams can be received in a portion with substantially the same sensitivity), so the scanning start timing of the respective laser beams is shifted.

In addition, the width of the light receiving surface 49a in the sub scanning direction can be shortened, so the light receiving surface can be made small. Thus, the BD sensor 49 can be made small, so the space of mounting the BD sensor 49 can be reduced.

Thus, the laser printer 1 using the multi-laser beam scanner 12 can be made smaller.

[0030]

[Second Embodiment]

The following explains a second embodiment of the laser beam scanner of this invention with reference to Fig. 5.

Fig. 5(A) is a schematic view showing the BD optical path in a cross section in the sub scanning direction. Fig. 5(B) is an explanatory view showing the relationship between the beam spots going through a slit and the light receiving surface 49a of the BD sensor 49. Fig. 5(C) is an explanatory view showing the relationship between the beam spots entering the BD sensor and the light receiving surface 49a of the BD sensor 49. Furthermore, the structures other than the structure on the BD optical path are the same structure as in the first embodiment.

[0031]

As shown in Fig. 5(A), before the BD sensor on the BD optical path, a member 48 is placed in which a slit 48a (Fig. 5(B)) is formed. A collecting lens 46 is placed between the member 48 and the BD sensor 49. The laser beam LB reflected by the polygon mirror 23 is imaged on the slit 48a on the BD optical path, and the laser beam LB emitted from the slit 48a is

imaged on the light receiving surface 49a (Fig. 5(C)) of the BD sensor 49 by the collecting lens 46.

Here, the relationship of $y1 > y2$ is established, and the horizontal magnification of the optical system in the sub scanning direction after the slit is smaller than one. That is, the relationship of $L2/L1 < 1$ is established. x1 and x2 are arbitrary.

That is, the width in the sub scanning direction of the beam spot entering the light receiving surface 49a of the BD sensor 49 can be made shorter than the width in the sub scanning direction of the beam spot entering the slit 48a. Thus, the same effects as in the first embodiment can be shown.

Additionally, by shifting the mounting position of the slit 48a in the main scanning direction (writing direction), the individual difference in the scanning start timing in terms of manufacturing can be absorbed, so accuracy of the scanning start timing can be improved.

Furthermore, if an ordinary spherical lens is used as the collecting lens 46, the relationship of $x1 > 2$ can be established.

[0032]

[Other Embodiments]

(1) The same cylinder lens can be used as the first and second cylinder lenses 13 and 14 (corresponding to claim 2 of this invention). According to this structure, the number of parts in common increases, so the manufacturing cost of the laser beam scanner 12 can be reduced. (2) According to the above-mentioned respective embodiments, the structure is explained in which two fθ lenses (the first and second fθ lenses 21 and 22) are used, but the structure can also be used in which only one fθ lens having power in the both main and sub scanning directions can be used. (3) Instead of the first cylinder lenses 13 and 14, another lens or combination of lenses

having a characteristic in which the laser beams are collected in the single direction can be used.

(4) The laser beam scanner of this invention can be used for a copy machine, a printer provided with a facsimile machine, etc.

[0033]

[Corresponding Relationships of the Respective Claims and Embodiments]

The polygon mirror 23 corresponds to deflecting scanning means of claim 1, the second fθ lens 22 corresponds to first collecting means, and the BD sensor 49 corresponds to detecting means. Additionally, the first cylinder lens 13 corresponds to second collecting means, and the second cylinder lens 14 corresponds to third collecting means.

[Brief Description of the Drawings]

Fig. 1 is an explanatory view showing a partial cross section in which a laser printer 1 is viewed from a direction perpendicular to a paper transfer direction.

Fig. 2 is an explanatory view showing a main structure of a laser beam scanner 12.

Fig. 3(A) is a schematic view showing a writing optical path cut in a sub scanning direction. Fig. 3(B) is a schematic view showing a BD optical path cut in the sub scanning direction.

Fig. 4(A) is an explanatory view showing the relationship between beam spots on the writing optical path and a light receiving surface 49a of a BD sensor 49. Fig. 4(B) is an explanatory view showing the relationship between the beam spots on the BD optical path and the light receiving surface 49a of the BD sensor 49.

Fig. 5(A) is a schematic view showing the BD optical path cut in the sub scanning direction. Fig. 5(B) is an explanatory view showing the relationship between beam spots goring through a slit and the light receiving surface 49a of the BD sensor 49. Fig. 5(C) is an explanatory

view showing the relationship between the beam spots that enter the BD sensor and the light receiving surface 49a of the BD sensor 49.

Fig. 6 is an explanatory view showing a main structure of a conventional laser beam scanner.

[Explanation of the Symbols]

1	Laser printer
12	Laser beam scanner
13	First cylinder lens (second collecting means)
14	Second cylinder lens (third collecting means)
21	First fθ lens
22	Second fθ lens (first collecting means)
23	Polygon mirror (deflecting scanning means)
25	Mirror
47	Laser light source
49	BD sensor (detecting means)
LB	Laser beam

[Document] Abstract

[Abstract]

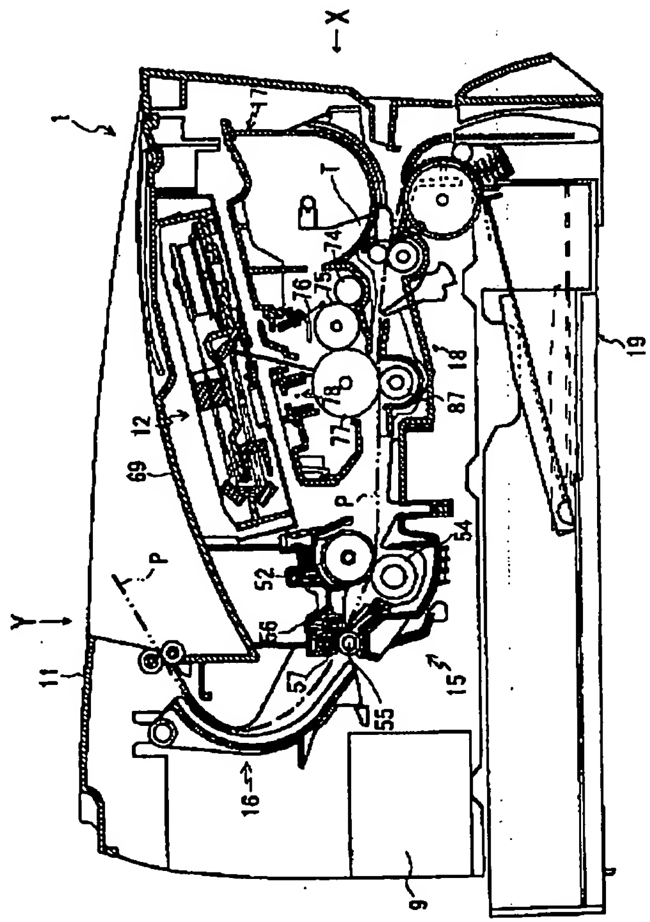
[Problem]

To realize a laser beam scanner that can reduce a width in a sub scanning direction that is necessary to enter the respective laser beams emitted from a plurality of laser light sources to a BD sensor.

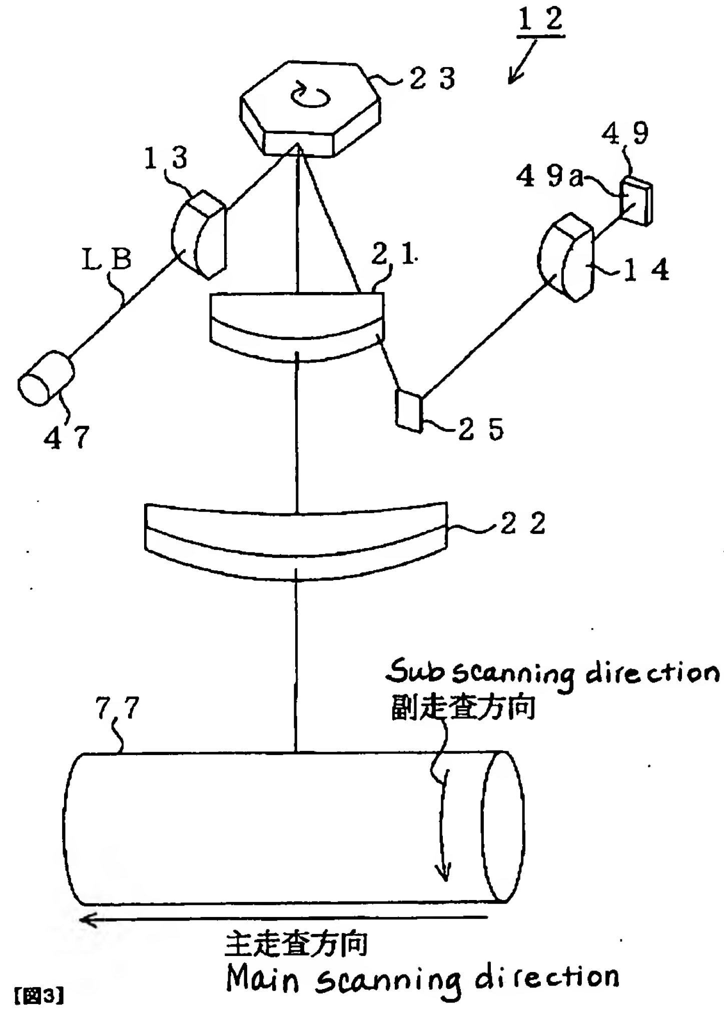
[Solving Means]

The horizontal magnification L2/L1 in a sub scanning direction on an optical path from a polygon mirror 23 to a photosensitive body drum 77 and the horizontal magnification L4/L3 in a sub scanning direction on an optical path from the polygon mirror 23 to the BD sensor 49 is in the relationship of L2/L1>L4/L3. The respective laser beams LB are reduced in the sub scanning direction. Therefore, the width of the light receiving surface of the BD sensor in the sub scanning direction can be made smaller than the width of the laser beam scanner in the relationship of L2/L1=L4/L3.

[Selected Figure] Fig. 3

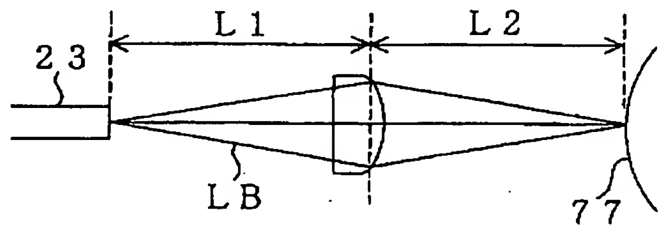

X
1
17
T
74
76
75
78
77
12
69
P
52
56
Y
11
57
55
15
16
54
87
18
19
9

【図2】

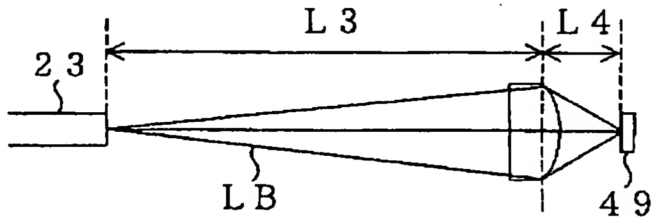

12
23
13
49
49a
LB
21
14
47
25
22
Sub scanning direction
副走査方向
77
主走査方向
Main scanning direction

【図3】

Cross section of writing optical path in sub scanning direction
（A）書込み光路の副走査断面

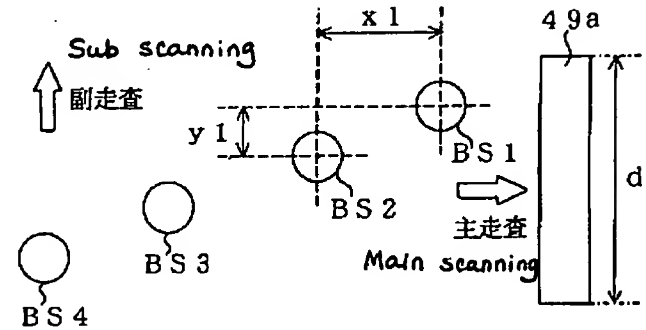


Cross section of BD optical path in sub scanning direction
（B）BD光路の副走査断面

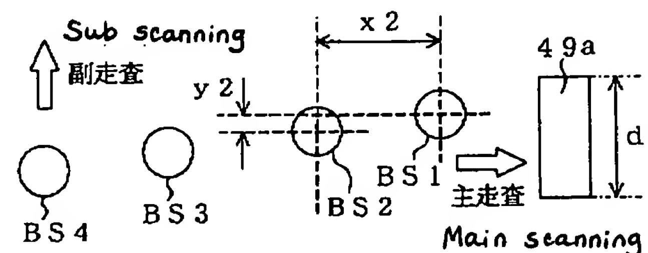


【図4】

Beam spots on writing optical path
（A）書込み光路におけるビームスポット



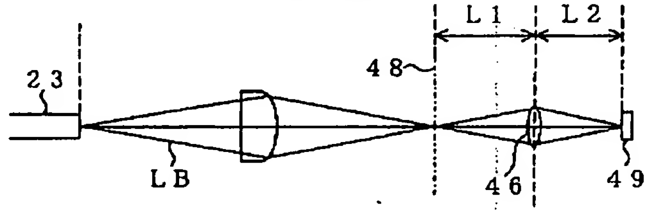
Beam spots on BD optical path
（B）BD光路におけるビームスポット



【図5】

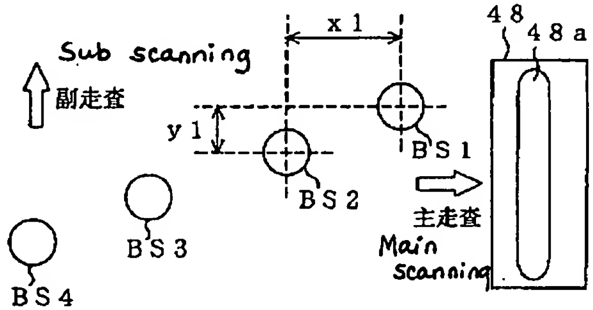
Cross section of BD optical path in sub scanning direction

(A) BD光路の副走査断面



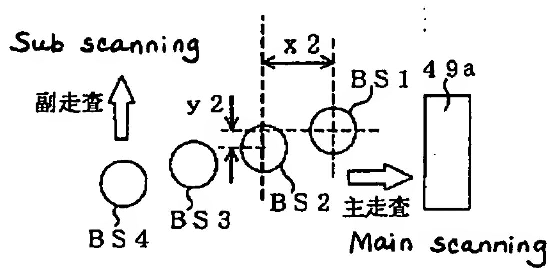
Beam spots going through slit

(B) スリットを通過するビームスポット

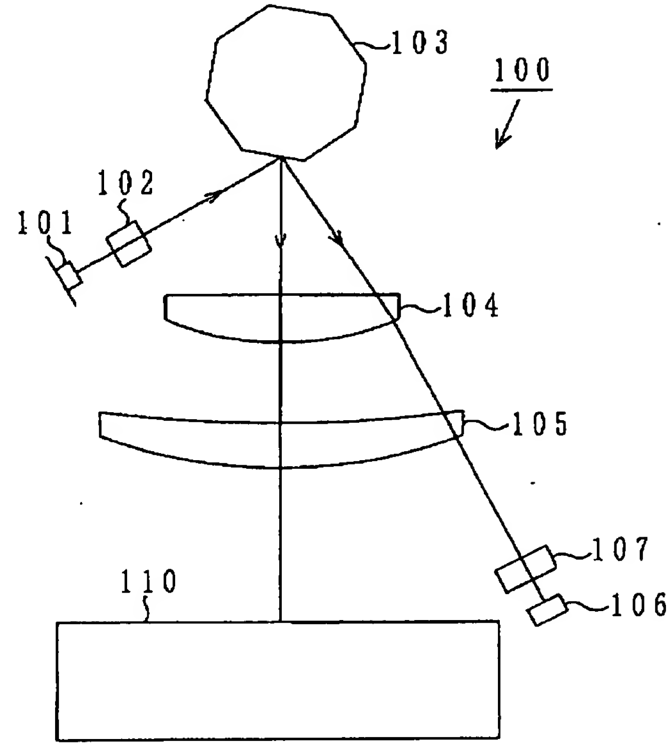


Beam spots entering BD sensor

(C) BDセンサに入射するビームスポット



【図6】



【書類名】 要約書

【要約】

【課題】複数のレーザ光源から出射された各レーザビームをBDセンサに入射させるために必要な副走査方向の幅を小さくすることができるレーザビームスキャナを実現する。

【解決手段】ポリゴンミラー23から感光体ドラム77に至る光路における副走査方向の横倍率L2／L1と、ポリゴンミラー23からBDセンサ49に至る光路における副走査方向の横倍率L4／L3とは、L2／L1＞L4／L3の関係にあり、各レーザビームLBは、副走査方向に縮小されている。し